

What is claimed is:

- 1        1. A computer-implemented method for updating a process recipe in a CMP process for a  
2            multilayer wafer, comprising the steps of:  
3            (a) inputting a model for CMP processing of a wafer having at least first and second  
4            layers comprising at least one control parameter, said model comprising a first component that  
5            predicts a value for a characteristic of the first layer and a second component that predicts a  
6            value for a characteristic of the second layer;  
7            (b) determining a process recipe based upon the model of step (a);  
8            (c) receiving a measured value of the characteristic of the first layer and/or the  
9            characteristic of the second layer for a wafer processed according to the process recipe of step  
10          (b); and  
11          (d) determining an updated model based upon the difference between the measured value  
12          and the predicted value of the characteristic.

- 1        2. The method of claim 1, wherein the model determines a first process recipe for the first  
2            layer of the wafer and a second process recipe for the second layer of the wafer.

- 1        3. The method of claim 1, wherein the model is defined as:

$$2 \qquad Y_t = Y_A + Y_B,$$

3        where

- 4             $Y_t$  is the model for a CMP process for a multi-layer wafer;  
5             $Y_A$  is the model for a CMP process for the first layer of the wafer; and  
6             $Y_B$  is the model for a CMP process for the second layer of the wafer.

- 1 4. The method of claim 1, wherein the characteristic of the first and second layers of the  
2 wafer comprises film thickness, and/or the control parameter comprises polishing time.
- 1 5. The method of claim 1, wherein the model of step (a) defines a plurality of regions on a  
2 wafer and a measured value for the wafer characteristic for each of the plurality of  
3 regions is received in step (c).
- 1 6. The method of claim 1, wherein the processing recipe comprises a plurality of polishing  
2 steps.
- 1 7. The method of claim 1, wherein the model accounts for a tool state of a tool used in the  
2 CMP processing of a wafer.
- 1 8. The method of claim 1, further comprising developing a model, said model development  
2 comprising the steps of  
3 (e) inputting pre-polished wafer characteristics for one or more wafers;  
4 (f) receiving measured values of the wafer characteristics for the one or more wafers  
5 processed according to a processing recipe;  
6 (g) providing a model defining the effect of tool state on polishing effectiveness; and  
7 (h) recording the pre-polished and post-polished wafer characteristic on a recordable  
8 medium.
- 1 9. The method of claim 8, wherein model development further comprises fitting the data to  
2 a curve that establishes a relationship between the wafer characteristic and the control  
3 parameter.

1 10. A method of controlling a characteristic of a wafer in a CMP operation, comprising the  
2 steps of:

3 (a) providing a model for CMP processing of a wafer having at least first and second  
4 layers comprising at least one control parameter capable of being controlled, comprising a  
5 first component that predicts a value for a characteristic of the first layer and a second  
6 component that predicts a value for a characteristic of the second layer;

7 (b) polishing a wafer using a first polishing recipe based upon the model of step (a);

8 (c) measuring the wafer characteristic for a wafer processed according to the process  
9 recipe of step (b); and

10 (d) determining an updated model based upon the difference between the measured value  
11 and the predicted value of the wafer characteristic.

1 11. The method of claim 10, further comprising:

2 determining an updated process recipe based upon the updated model of step (d).

1 12. The method of claim 10, wherein the model determines a first process recipe for the first  
2 layer of the wafer and a second process recipe for the second layer of the wafer.

3 13. The method of claim 10, wherein the model accounts for the tool state of a tool used in  
4 the CMP processing of a wafer.

1 14. The method of claim 10, wherein the model is defined as:

2 
$$Y_t = Y_A + Y_B,$$

3 where

4  $Y_t$  is the model for a CMP process for a multi-layer wafer;

5           Y<sub>A</sub> is the model for a CMP process for the first layer of the wafer; and  
6           Y<sub>B</sub> is the model for a CMP process for the second layer of the wafer.

1       15. The method of claim 10, wherein the characteristic of the first and second layers of the  
2       wafer comprises film thickness, and/or the control parameter comprises polishing time.

1       16. The method of claim 10, wherein the model defines a plurality of regions on a wafer and  
2       identifies a wafer material removal rate in a polishing step of a polishing process for each  
3       of the regions.

1       17. The method of claim 10, wherein the polishing process comprises a plurality of polishing  
2       steps.

1       18. The method of claim 16, wherein the plurality of regions in the model of step (a)  
2       comprises regions extending radially outward from a center point on the wafer.

1       19. The method of claim 10, wherein the polishing of step (b) comprises polishing the wafer  
2       at a plurality of polishing stations.

1       20. The method of claim 19, wherein determining the updated polishing model of step (d)  
2       comprises calculating updated models for each of the plurality of polishing stations.

1       21. The method of claim 20, wherein the updated polishing model for each of the plurality of  
2       polishing stations accounts for the tool state of the individual polishing stations.

1       22. The method of claim 19, wherein, the initial wafer thickness for each of the polishing  
2       stations is provided by the prediction from previous polishing stations.

1       23. An apparatus for polishing a wafer in a CMP operation having controlled characteristics,  
2       comprising:

3 (a) a model for comprising at least one control parameter capable of being controlled for  
4 CMP processing of a wafer having at least first and second layers, comprising a first  
5 component that predicts a value for a characteristic of the first layer and a second component  
6 that predicts a value for a characteristic of the second layer;

7 (b) polishing means for polishing a wafer using a first polishing recipe based upon the  
8 model of step (a);

9 (c) measuring means for measuring the wafer characteristic for a wafer processed  
10 according to the process recipe of step (b); and

11 (d) calculating means for determining an updated model based upon the difference  
12 between the measured value and the predicted value of the wafer characteristic.

1 24. The apparatus of claim 23, wherein the model defines a first process recipe for the first  
2 layer of the wafer and a second process recipe for the second layer of the wafer.

1 25. The apparatus of claim 23, wherein the model accounts for the tool state of a tool used in  
2 the CMP processing of a wafer.

1 26. The apparatus of claim 23, wherein the characteristic of the first and second layers of the  
2 wafer comprises film thickness, and/or the control parameter comprises polishing time.

1 27. The apparatus of claim 23, wherein the model defines a plurality of regions on a wafer  
2 and identifies a wafer material removal rate in a polishing step of a polishing process for  
3 each of the regions.

1 28. The apparatus of claim 27, wherein the polishing process comprises a plurality of  
2 polishing steps.

29. The apparatus of claim 23, wherein the polishing of step (b) comprises polishing the wafer at a plurality of polishing stations.

30. An system for polishing a wafer in a CMP operation having controlled characteristics, comprising:

5 (a) a model for comprising at least one control parameter capable of being controlled for CMP processing of a wafer having at least first and second layers, comprising a first component that predicts a value for a characteristic of the first layer and a second component that predicts a value for a characteristic of the second layer;

10 (b) CMP polishing station for polishing a wafer using a first polishing recipe based upon the model of step (a);

(c) a metrology tool for measuring the wafer characteristic for a wafer processed according to the process recipe of step (b); and

(d) a computer for calculating an updated model based upon the difference between the measured value and the predicted value of the wafer characteristic.

15